Using Geographic Information Systems in the Military Decisionmaking Process

by Captain Brian J. Doyle

Throughout the history of warfare, chief weapons of all victorious armies have been not rifles or bombs, but maps. As David Livingstone explains, "Throughout its history, geography has frequently cast itself as the aide-de-camp to militarism… maps, it was long known, were as vital implements of warmongering as gunnery."[1]

Maps are used at all echelons to command and control the fight, plan the next battle, and analyze the last one. They convey information to the rifleman and the general. However, current maps found in command posts, from company to division levels, are outdated. The information represented, in its two-dimensional portrayal of the contested terrain, is incomplete and inadequate compared to today's technology.

Geographic information systems (GIS) are quickly becoming the medium of choice for governing, maintaining, and policing communities across the nation, but its inroads to military services are extremely limited. Even in our "digitized" divisions, the ability to convey and portray information spatially has not been developed to the optimum level. The age of the map board with its acetate overlays and alcohol pens should be over. The capabilities of the GIS can revolutionize the way we conduct war.

Geographic information systems are, as Gregory Johnston describes, "integrated computer tools for handling, processing, and analyzing geographic data, that is, data explicitly referenced to the surface of the Earth."[2] These computerized tools are common today in all realms of society from government to commercial to academia. Johnston further explains that GIS uses include, "the automated measurement and analysis of geographically distributed resources, and the management of distributed facilities."[3]

The Corps of Engineers has extensively used this technology for analyses and in producing maps and graphics.[4] GIS' use can and should be expanded. This is a tool that is not solely useful to higher echelon staffs. The dynamic information that is produced and analyzed from a spatial database can be used by battalion-level staff officers and company-level commanders. The question of implementing this tool becomes chiefly one of information management. This article explores an avenue for future exploitation of this technology.

Implications for the applicability of GIS are most clearly seen in the seven steps of the military decisionmaking process (MDMP). This process is carried out in various manners at all levels of command.

Among its steps specifically, mission analysis, course of action development, course of action analysis, and course of action comparison, the use of a GIS could revolutionize how leaders and their staffs visualize the battlefield.[5] Many factors such as topography, friction surfaces, soils, and line-of-sight analysis are currently conducted using a 1:50,000 map and possibly a few aerial photographs of key terrain. By linking these resources and the multitude of additional information available, commanders could have instant access to a much-enhanced picture from which to base their tactical decisions.

Current Applications

Currently, the engineer branch maintains GIS capabilities. They have a system in place that builds, maintains, and operates the GIS by organizing assets down to division-level topographic companies that provide assets as needed to the brigade. They have two different organizations for their topographic companies, a digital division and a nondigital division, with the primary difference being the integration of the digital assets to the information database assembled.

This organization is well thought out and incorporates many different battlefield operating systems and their specialized geographic information needs.[6] However, it still falls short of what it can provide leaders. Further, this technology is not well known and therefore not fully exploited in the lower command echelons. For example, U.S. Army Field Manual (FM) 17-95, *Cavalry Operations*, Annex B, which details the new innovations pertaining to "digital cavalry," makes no reference at all to the capabilities that the division topographic company could lend to the cavalry fight.[7] All commanders (digital or not) are constantly engaged in the quest for information on terrain and environment and could benefit greatly from integrating a GIS database into their decisionmaking cycle. We need to educate and train the force, and then imbed our doctrine with the advantages that this technology offers to battlefield commanders.

Proposed Integration

The MDMP is a series of steps conducted at each level of command.[8] Many of these steps would benefit from including GIS technology. Of specific interest are the steps that make up step three, "Make a tentative plan."[9] This is the step that will benefit the most from including GIS in the planning process. At the brigade and battalion levels, this will revolutionize the way in which our battles are planned. Instead of staff officers huddled around a two-dimensional map board, making subjective decisions concerning the terrain and environment, a GIS will enable informed decisions based not only on topographic maps, but remote sensing, aerial photography, recent surveys, visual descriptions from local noncombatants, census data, statistical data, digital elevation graphs, digital elevation models, digital orthophotoquads, and many other sources.[10]

GIS has the ability to analyze areas based on weighted terrain values, which greatly assists in determining the key terrain and likely avenues of approach. This will allow the tentative plan to be developed quickly and accurately and provide models from which to explore the impacts of the terrain on the different courses of action. This would also allow planners to better mitigate or exploit the impact of the physical environment.

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This should be a skill incorporated into all captain's career courses. The ability to operate a GIS and to use its analytic capabilities is akin to reading maps at this level of planning. This base of knowledge would allow the Army to attain a higher level of situational awareness at tactical decision points.

Case Study for Implementation

At the Combined Maneuver Training Center (CMTC) in Hohenfels, Germany, no place is more feared or respected than the killing ground known as fifteen tango (15T). In this 1.5-kilometer by 5-kilometer box of rolling hills with permeable wood lines on all edges, platoons, companies, troops, and battalions are put to the test monthly. Control of this key avenue of approach is often the only variable that exists between winning and losing in any east-west fight at the CMTC.

For the purposes of a case study in GIS application, we are going to look at the advantages this technology would provide a commander of a heavy division cavalry troop. This study is largely based on an actual battle that took place at the CMTC between 14 and 15 September 2000, with A Troop, 1st Squadron, 1st United States Cavalry in support of the 173d Infantry Regiment.

At 0300 hours, at the squadron tactical operations center, the squadron commander issues his guidance for the squadron's mission that will commence the following day. The squadron, as part of a light infantry brigade, will screen in depth to identify and destroy elements on the enemy's reconnaissance patrols. Then, following identification and destruction of the lead regiment's combat reconnaissance patrol, A Troop, in the south, will collapse its screen, move northwest and form a defense in depth behind B Troop, centered on the western edge of 15T. In this position, the squadron will guard the northern boundary of the brigade, and de-

ny the enemy penetration of that boundary.

Further constraints require that the rear movement of A Troop occur at 0200 hours the following evening. The A Troop commander cannot rehearse this move and cannot recon the terrain for fear that local observers will provide information to the enemy that will lead him to suspect such a maneuver. The intent is to have the enemy believe that the force that destroyed his reconnaissance element, namely a screening force of two troops abreast, is still the formation he will face when his main body arrives. Due to the existence of these informants and dismounted reconnaissance teams, no movement toward 15T by A Troop is permitted prior to execution time.

The A Troop commander must now select a route that will allow his unit of 13 cavalry fighting vehicles, nine tanks, and two track-mounted mortars, a total of 24 combat vehicles, to move along a route 10-kilometers long through friendly positions in the middle of the night. He must then establish a defense in depth focused on an engagement area that will not be visible in daylight until 30 minutes after the expected enemy attack.

This mission was executed with slightly less than perfect results. A 1:50,000-meter map, minimal terrain analysis information, and applicable Army Field Manuals were used. The unit could have greatly expanded their horizons with the aid of GIS.

Most GIS software packages today can easily be loaded onto laptop computers. This package can be set up and operating in the back of any command post vehicle, enabling the commander to analyze the terrain, model possible routes, and identify probable defensive positions prior to devising a plan for the unit to execute.

The A Troop commander needed compact disks from the S2 containing the applicable data layers, which could be distributed with the operation order. Going back to his troop tactical operations center (TOC), the commander could then load the information and run the analysis. No other link would be needed. Obviously, if there was a way of connecting the TOCs in real time, then information could be updated in both directions, but the emphasis on this system is its independence. The commander will gain benefit with systems that exist today; no future technology is needed to make this system operable. He could, for example, analyze the possible routes through a network function to determine the most direct and quickest routes, or which routes provide the best cover and concealment.

Using FM 3-90.1, *Tank and Mechanized Infantry Company Team*, as a guide, the commander could systematically analyze the engagement area by using these engagement development steps:[11]

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Step 1 – Identify likely enemy avenues of approach. Through the network analysis, the commander could identify what road would hold which vehicle at what rate of speed. By analyzing the biodensity of the wooded areas, the GIS could provide an idea of other possible routes of infiltration.

Step 2 – Determine likely enemy scheme of maneuver. Likely routes into the area and the routes needed to get to the objective can be easily determined through spatial analysis of the slope and aspect of the terrain.

Step 3 – Determine where to kill the enemy. Through spatial analysis, those areas that form the deadspace will be identified, as well as those areas which will bottleneck the enemy's movement. This information can be quickly translated into target reference points (TRPs) for concentration of artillery fires. This same information also will allow the commander to plan and integrate obstacles.

Step 4 – Plan and integrate obstacles to further deny the enemy ability to maneuver.

Step 5 – Emplace weapons systems. Focusing on the emplacement of weapons systems is tailor made for GIS. In this scenario, vehicle commanders do not have the luxury of seeing the actual terrain and sighting in their fighting positions. Through information regarding land cover, elevation slope aspect, and slope angle, as well as through line-of-sight analysis, the commander can determine the ideal locations for all of his vehicles to affect the fight.

Step 6 – Plan and integrate indirect fires. The results of Step 5 will translate nicely into Step 6 by identifying indirect fire targets and clearly identifying areas difficult to engage with indirect fire.

Step 7 – Rehearse the execution of operations in the engagement area. GIS can also assist the commander through its ability to model different possibilities; through modeling, the commander will identify holes in the plan or how the plan can be improved prior to execution.

During the battle described above, the element of time was crucial. A Troop had plenty of time on the screen line, but not enough in their defensive positions. Time in the assembly area is often a long and uneventful prelude to a confusing and rapidly developing period of action. These periods of planning can be greatly enhanced through applying GIS during the planning cycle. Generally, the enemy's presence denies us the opportunity to re-

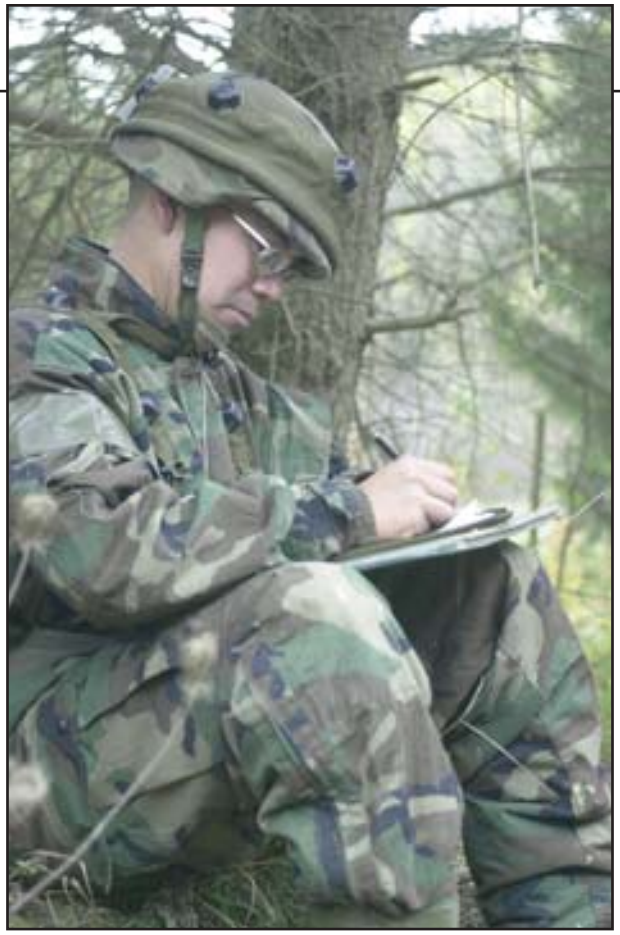
hearse on the ground on which we will fight. However, GIS can better prepare the commander for the future fight and provide him with invaluable perspective in visualizing the battle.

Information Management

In discussing battlefield visualization, FM 101-5, *Staff Organization and Operations*, states: "It is critical to mission accomplishment that commanders have the ability to visualize the battlefield. Therefore, in his intent statement, the commander must clearly articulate his battlefield visualization to his subordinates and staff to ensure the optimum development and execution of his concept of operations."[12]

What better way to bring this visualization to life than through the use of GIS? In discussing the relevance of this type of data, FM 3-34.230, *Topographic Operations*, states: "Computer technology has changed the Army's mapping, data-collection, and battlefield-planning processes. As computer power and accessibility have grown during the 1970s and 1980s, new methods of map making and terrain analysis have been developed. Military commanders have long realized the interdependence of the earth's land features and their success on the battlefield. Those military leaders who stand out in history visualized the terrain and its effects on the battle's outcome. Today's topographic engineer (along with his GIS tools) is able to represent the terrain and its effects more accurately and faster to help the commander visualize the terrain. The commander's knowledge of the terrain will allow him to obtain a superior advantage in shaping the battle space; it is a key portion of information dominance leading to successful operations."[13]

The key to how technology can benefit the fight is the level to which the information is disseminated. Current doctrine shows that this information is often developed at division as part of the division engineer's function and pushed down to only brigade commanders.[14] This manual was published in August 2000; however, based on the comment in the above cited paragraph concerning the progress computers made in the "1970s and 1980s," I think its safe to assume that little has actually changed since its original publication as FM 5-105 in 1993.[15] Since then, technology has taken even greater steps, and with available laptop computers and writable CD ROM drives, battalion-level staffs should have the ability to create GIS layers, and company-level commanders should have access to the information as part of their decisionmaking process.



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GIS technology exists. The issue is primarily one of information dissemination and awareness of existing capabilities. For as long as we have had an Army, we have relied on maps. Our ability to develop overlays on acetate to depict every part of the battle and every influencing factor is well established. The problem has always been our ability to digest data and create useful information. The GIS provides an almost unlimited ability to digest all spatial data. Further, through analytic capabilities, a battlefield commander can manage this information in ways that are not possible with traditional maps.

The future Army, with its goal of interconnecting all combatants in a constant flow of data and images, offers even more possibilities in which GIS can process and present information. The time to establish this technology is now. We can actively employ GIS at the company level through currently in-place systems by purchasing GIS software and training programs to develop user proficiency. This system is the next step for the map, and it will provide combat leaders with the information that they need to make decisions that will win battles and save lives on future battlefields.

Notes

[1]David Livingstone, *The Geographical Tradition*, Blackwell Publishing, Oxford, 1992, p. 352.

[2]Johnston, Gregory, Pratt and Watts, *The Dictionary of Human Geography, 4th Edition*, Blackwell Publishing, Oxford, 2000.

[3]Ibid.

[4]U.S. Army Field Manual (FM) 3-34.230, *Topographic Operations*, Department of the Army, U.S. Government Printing Office, Washington, D.C., 3 August 2000.

[5]FM 101-5, *Staff Organization and Operations*, Department of the Army, U.S. GPO, Washington, D.C., 31 May 1997, Figure 5-1.

[6]FM 3-34.230, *Topographic Operations.*

[7]FM 17-95, *Cavalry Operations*, Department of the Army, U.S. GPO, Washington, D.C., 24 December 1996, Annex B.

[8]Ibid., Figure 2-3.

[9]Ibid.

[10]Michael N. Demers, *Fundamentals of Geographic Information Systems*, John Wiley & Sons, 2000.

[11]FM 3-90.1, *Tank and Mechanized Infantry Company Team,* Department of the Army, Washington, D.C., 9 December 2002.

[12]FM 101-5, *Staff Organization and Operations*.

[13]FM 3-34.230, *Topographic Operations*.

[14]Ibid.

[15]FM 5-105, *Topographic Operations*, Department of the Army, Washington, D.C., 1993, superseded by FM 3-34.230.

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